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Commuting Physical Activity and Risk of Colon Cancer in Shanghai, China

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Colon cancer incidence rates have been rapidly increasing in Shanghai, China, for reasons still unclear. Low physical activity is a known risk factor for colon cancer. The authors examined the effects of physical activity, particularly commuting physical activity, and its joint effects with body mass index on colon cancer risk in a population-based, case-control study. The study included 931 incident colon cancer patients and 1,552 randomly selected controls in Shanghai between 1990 and 1993. Colon cancer risk was significantly reduced among subjects with high commuting physical activity (odds ratio (OR) = 0.52, 95% confidence interval (CI): 0.27, 0.87 for men; OR = 0.56, 95% CI: 0.21, 0.91 for women), particularly among those who had high commuting physical activity for at least 35 years (OR = 0.34, 95% CI: 0.09, 0.76 for men; OR = 0.31, 95% CI: 0.07, 0.72 for women). Commuting physical activity significantly modified the risk conferred by high body mass index, with the highest risk observed among those at the highest quintile of body mass index and the lowest activity level (OR = 6.43, 95% CI: 1.82, 8.54 for men; OR = 7.42, 95% CI: 2.84, 10.01 for women). Our results suggest that regular and frequent physical activity over a long period of time protects from colon cancer and significantly modifies the body mass index-associated risk.

body mass index; case-control studies; China; colonic neoplasms; motor activity; risk

Abbreviations: CI, confidence interval; MET, metabolic equivalent; OR, odds ratio.

Low physical activity has been linked to increased risk of several cancers (1), with particularly convincing evidence for colon cancer (2). However, details of this association are still unclear. Previous studies of colon cancer have focused primarily on occupational and leisure physical activities (1–6). Most of these studies were conducted in Western countries, where high incidence rates of colon cancer are coupled with a high prevalence of obesity and a relatively sedentary lifestyle (1, 4).

Colon cancer incidence rates have been increasing rapidly for two decades in Shanghai, China, a relatively low-risk country in the past (7). Increasing Westernization of lifestyle, including transportation means and dietary practices, may have contributed to the rising colon cancer trends. The transition to a more Western-like lifestyle, however, has not reached the entire population. The large variations in lifestyle factors enhance the opportunity for evaluation of dose response in cancer risks. We conducted a population-based, case-control study of four gastrointestinal cancers in Shanghai, China. In this report, we examined the effect of various physical activities on colon cancer risk, with particular attention to commuting physical activity which constituted a large component of daily activities among the majority of the Shanghai population.

MATERIALS AND METHODS

Study population

This investigation is part of a population-based, case-control study of gastrointestinal cancers (pancreas, esophagus, colon, and rectum) in urban Shanghai. The study design has been described in detail elsewhere (8, 9). In brief, eligible cases were residents of the 10 districts constituting urban Shanghai, aged 30–74 years, and newly diagnosed with colon cancer (*International Classification of Diseases*, Ninth Revision, codes 153.0–153.9) between October 1990

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and July 1992. Cases were identified through a rapid reporting system established by the population-based Shanghai Cancer Registry. A total of 931 colon cancer cases (462 males and 469 females) were interviewed, yielding a response rate of 92 percent. All cases were confirmed by either histopathology (95 percent) or other methods including surgical examination, computed tomography scan/ultrasound, or radiographic examination (5 percent). Excluded from the study were 59 patients who died, 14 patients who moved away, and seven patients who refused the interview.

Controls were randomly selected from residents of urban Shanghai and frequency matched to the expected age (5-year categories) and sex distributions of the four gastrointestinal cancers combined in the overall study. Personal identification cards from the Shanghai Resident Registry were used to select controls. The cards contained information on name, address, date of birth, gender, and other demographic factors. Two random numbers (a four-digit number for locating a drawer and a three-digit number for locating a personal identification card within the drawer) were generated to select each control. For each control chosen, an alternate control subject was also selected. If the first control could not be interviewed, the alternate was enrolled. A total of 1,552 controls were interviewed, yielding a participation rate of 85 percent. Of these, 240 (15 percent) were alternates. The study was approved by the Institutional Review Board of the Shanghai Cancer Institute, China, and the US National Cancer Institute.

Data collection

Study participants were interviewed in person by trained interviewers, using a structured questionnaire to elicit information on demographic and residential characteristics, height and weight history, diet, cigarette smoking, alcohol and other beverage consumption, medical history, reproductive history, family history of cancer, lifetime occupational history, and commuting and leisure time physical activities. For commuting physical activity, participants reported the means of commuting, including walking, riding on a bus, and riding a bicycle, and for each method of commuting, the number of days a week and daily minutes spent for the round trip to and from work at different age periods (i.e., ages 20–29, 30–44, 45–54, and ≥55 years) over their lifetime. For leisure physical activity, information on the average minutes spent per week on each of 13 specific activities, such as badminton, basketball, table tennis, taiji, and swimming, at different age periods (i.e., ages 20–29, 30–44, 45–54, and ≥55) over their lifetime was collected.

The intensity of commuting and leisure physical activities was estimated by the number of hours spent per week on each activity multiplied by its typical energy expenditure, expressed as metabolic equivalents (METs) to yield a MET-hour/week score (10, 11). A MET is the ratio of the metabolic rate during a specific activity to the resting metabolic rate, that is, while sitting quietly. If more than one published intensity level was available for a specific activity, the moderate or general MET was chosen (10, 11). The following MET values were used for activities performed in commuting physical activity: 2.5 for walking, 8.0 for bicycling, and 1.0 for riding on a bus. For analysis, commuting physical activity and leisure physical activity variables were grouped into tertiles according to the distribution of MET scores in the control group. The cutpoints for low, medium, and high levels of commuting physical activity were less than 48.3, 48.3–94.3, and greater than 94.3 MET-hours/week, respectively. The corresponding cutpoints for leisure physical activity were less than 9.2, 9.2–13.6, and greater than 13.6 MET-hours/week, respectively.

Occupational physical activity levels were estimated by lifetime average energy expenditure, which classified each of over 300 specific jobs into low (<8 kJ/minute), moderate (8–12 kJ/minute), and high (>12 kJ/minute) groups (11). The index of lifetime average energy expenditure was calculated by multiplying the energy expenditure of each job with years on the job, summing the product values over all jobs, and dividing the sum by total years of employment. Detailed methods in assigning occupational physical activity levels were reported elsewhere (12).

Data on adult height and weight history, including usual adult weight, highest adult weight, and weight at various age periods, were collected. Analyses of body mass index based on the usual adult weight are presented in this report, although similar findings were observed for body mass index at various age periods. The usual body mass index of each individual was calculated as the usual adult weight (kg)/adult height (m)^2. Quintiles of usual body mass index were determined using gender-specific cutpoints among the controls: quintile 1: less than 19.2, quintile 2: 19.2–20.3, quintile 3: 20.4–21.3, quintile 4: 21.4–22.8, and quintile 5: greater than 22.8 kg/m^2 for men and quintile 1: less than 19.0, quintile 2: 19.0–20.5, quintile 3: 20.6–21.9, quintile 4: 22.0–23.6, and quintile 5: greater than 23.6 kg/m^2 for women.

Statistical analysis

Colon cancer risk in relation to physical activity variables was estimated by odds ratios and 95 percent confidence intervals, using multiple logistic regression models (13). The lowest level of each variable was used as the referent group, and risks were estimated for men and women separately. Potential confounders for the basic model were selected by means of forward-stepwise logistic regression (using $p < 0.15$ as the entry criterion and $p > 0.20$ as the removal criterion). Age was forced into the basic model to yield the final model. Tests for trend were performed using the median values for each category. Interaction between commuting physical activity and body mass index was evaluated by adding an interaction term into the logistic regression model. Continuous variables of commuting physical activity and body mass index were used to assess statistical significance for interactions by the likelihood-ratio test. Categorical variables of commuting physical activity and body mass index were used to compute odds ratios for the cross-categories of commuting physical activity and body mass index. In addition, colon cancer risk was further examined by anatomic subsites of proximal colon (cecum, appendix, ascending colon, hepatic flexure, transverse colon, and splenic flexure) and distal colon (descending and sigmoid colon). All odds ratios were adjusted for age, education, monthly family

TABLE 1. Characteristics of study subjects, Shanghai, China, 1990–1993

Characteristic	Men				Women			
	Cases		Controls		Cases		Controls	
	No.	%	No.	%	No.	%	No.	%
Total no. of subjects	462	100.0	851	100.0	469	100.0	701	100.0
Age (years)								
30–49	75	16.2	130	15.3	90	19.0	108	15.4
50–59	95	20.6	182	21.4	94	20.0	194	27.7
60–64	108	23.4	195	22.9	105	22.4	147	21.0
65–69	100	21.6	183	21.5	970	20.7	136	19.4
70–74	84	18.2	161	18.9	83	17.7	116	16.5
Educational level (years)								
0–6	144	31.6	313	37.5	260	56.9	399	57.8
7–12	143	31.3	258	31.9	95	20.8	159	23.1
≥13	169	37.1	264	31.6	102	22.3	132	19.1
Monthly income (yuan)								
<30	99	21.5	250	29.5	118	25.2	251	36.0
30–49	159	34.5	303	35.8	161	34.4	242	34.8
≥50	203	44.0	294	34.7	189	40.4	203	29.2
Marital status								
Married	427	92.4	769	90.4	372	79.3	543	77.5
Other	35	7.6	82	9.6	97	20.7	158	22.5
Body mass index*								
Quintile 1	80	17.4	171	20.1	86	18.5	139	20.0
Quintile 2	85	18.4	168	19.8	91	19.6	131	18.8
Quintile 3	68	14.8	169	20.0	80	17.2	147	21.2
Quintile 4	109	23.6	170	20.1	92	19.8	139	20.0
Quintile 5	119	25.8	169	20.0	116	24.9	139	20.0

* Quintiles of body mass index based on gender-specific distributions among control subjects. The following cutpoints were used: quintile 1: <19.2, quintile 2: 19.2–20.3, quintile 3: 20.4–21.3, quintile 4: 21.4–22.8, and quintile 5: >22.8 for men; and quintile 1: <19.0, quintile 2: 19.0–20.5, quintile 3: 20.6–21.9, quintile 4: 22.0–23.6, and quintile 5: >23.6 for women.

income, marital status, total energy intake, and intakes of red meat, carotene, and fiber and, for women, the number of pregnancies and menopausal status in addition. Except when indicated otherwise, all physical activity variables were adjusted for each other. Body mass index was not included in the final model, because adjusting for body mass index as a categorical or continuous variable did not significantly alter the results. All tests were two sided, with p values of less than 0.05 considered to be statistically significant. Individuals with missing values were excluded from specific analyses. The Stata statistical package, release 7.0 (Stata Corporation, College Station, Texas), was used for all analyses.

RESULTS

Colon cancer cases tended to have higher education, monthly income, and body mass index than did controls (table 1). Cases and controls were comparable with respect to distributions by age and marital status.

Colon cancer risk generally declined with increasing levels of each type of physical activity, including occupational, physical, and commuting physical activities, in both men and women (table 2). After adjusting the three physical activity variables for each other, we found that the trend remained significant only for commuting physical activity in both men ($p < 0.001$) and women ($p = 0.007$), and among women, also for occupational physical activity ($p = 0.009$). However, compared with the lowest tertile of physical activity, risk reduction was significant only for the highest tertile of commuting physical activity (odds ratio (OR) = 0.52, 95 percent confidence interval (CI): 0.27, 0.87 for men; OR = 0.56, 95 percent CI: 0.21, 0.91 for women). The associations with physical activities among both men and women were generally similar for proximal and distal cancers (data not shown).

TABLE 2. Gender-specific risk of colon cancer by levels of lifetime commuting, occupational, and leisure physical activity, Shanghai, China, 1990–1993

Physical activity	Level of physical activity: Low		Medium					High					p_{trend}*
	Cases/controls (nos.)	Odds ratio (referent)	Cases/controls (nos.)	Odds ratio†	95% confidence interval	Odds ratio‡	95% confidence interval	Cases/controls (nos.)	Odds ratio†	95% confidence interval	Odds ratio‡	95% confidence interval	
Men													
Occupational physical activity§	179/312	1.0	209/337	1.19	0.90, 1.59	1.23	0.93, 1.64	74/199	0.77	0.55, 1.15	0.81	0.59, 1.19	0.10
Leisure physical activity§,¶	64/165	1.0	64/161	0.97	0.65, 1.45	1.17	0.13, 1.95	49/162	0.64	0.57, 0.97	0.72	0.41, 1.07	0.06
Commuting physical activity§	218/280	1.0	141/281	0.98	0.34, 1.24	1.11	0.31, 1.23	103/290	0.56	0.32, 0.91	0.52	0.27, 0.87	<0.001
Women													
Occupational physical activity§	158/210	1.0	278/411	0.93	0.68, 0.13	0.96	0.69, 1.16	31/80	0.52	0.32, 0.91	0.64	0.39, 1.02	0.009
Leisure physical activity§,¶	64/114	1.0	59/107	0.97	0.62, 1.62	1.03	0.41, 1.59	56/113	0.79	0.54, 1.34	0.84	0.13, 2.25	0.15
Commuting physical activity§	236/232	1.0	121/231	0.92	0.51, 1.57	0.87	0.42, 1.52	110/238	0.58	0.24, 0.94	0.56	0.21, 0.91	0.007

* p_{trend} from the odds ratio described in the ‡ footnote.

† Adjusted for age, education, family income, marital status, total energy intake, intake of red meat, carotene, and fiber for both men and women and additionally for number of pregnancies and menopausal status for women.

‡ In addition to the adjustment for the variables mentioned in footnote †, adjusted also for the other two physical activity variables.

§ The corresponding cutpoints for low, medium, and high levels of commuting physical activity were <48.3, 48.3–94.3, and >94.3 metabolic equivalent (MET)-hours/week; those for leisure physical activity were <9.2, 9.2–13.6, and >13.6 MET-hours/week. The cutpoints for occupational physical activity measured by lifetime average energy expenditure were low (<8 kJ/minute), moderate (8–12 kJ/minute), and high (>12 kJ/minute).

¶ Analysis was also conducted using no leisure physical activity as a referent group, and no significant association was observed.

Colon cancer risks were comparable for commuting physical activity reported for all age periods, except for a weaker association with commuting physical activity at age 55 or more years in both men and women (table 3). The decline in risk with increased levels of commuting physical activity was most prominent for those who consistently maintained high levels of activities for at least 35 years (between ages 20 and 54 years), with a risk reduction of 66 percent in men and 69 percent in women. For subjects who had high levels of commuting physical activity for 25 years (regardless of whether during age periods 20–44 years or age periods 30–54 years), risk was reduced 54–61 percent. The commuting physical activity-related risks were similar for premenopausal and postmenopausal women at the time of diagnosis for colon cancer (data not shown).

We also examined colon cancer risk in relation to the time spent on daily commuting over the lifetime (table 4). Risk was reduced consistently with an increasing average time spent on cycling ($p_{trend} < 0.001$ for both men and women), with risk reduction of nearly 59 percent for those who rode a bicycle for more than 2 hours per day (OR = 0.41, 96 percent CI: 0.21, 0.83 for men; OR = 0.44, 95 percent CI: 0.12, 0.89 for women). To a lesser extent, risk was also reduced with increasing time spent on walking ($p_{trend} = 0.08$ for men and 0.007 for women). Walking for more than 30 minutes per day reduced colon cancer risk by 29 percent in men (OR = 0.71, 95 percent CI: 0.38, 1.06) and 43 percent in women (OR = 0.57, 95 percent CI: 0.31, 0.93).

Analyses of the joint effects of commuting physical activity and body mass index showed significant interaction on colon cancer risk in both men ($p = 0.002$) and women ($p < 0.001$) (table 5). Risks increased with decreasing commuting physical activity levels mainly among those at higher quintiles of body mass index, and risks increased with quintiles of body mass index mainly at medium or low levels of commuting physical activity. Compared with individuals at the lowest quintile of body mass index and a high physical activity level, the risk was more than sixfold for men (OR = 6.43, 95 percent CI: 1.82, 8.54) and sevenfold for women (OR = 7.42, 95 percent CI: 2.84, 10.01) at the highest quintile of body mass index and a low physical activity level.

The associations with physical activities in both men and women were essentially unchanged when cases diagnosed by methods other than histologic confirmation, including surgical examination, computed tomography scan/ultrasound, or radiographic examination, were excluded from the analysis.

DISCUSSION

In this large, population-based study in Shanghai, China, we found significant inverse associations between colon cancer risk and physical activity levels, particularly for commuting physical activity. Colon cancer risk was reduced with increasing hours spent on the daily commute and increasing years maintained at a high level of activity.

TABLE 3. Gender-specific risk of colon cancer by level of commuting physical activity in different age periods, Shanghai, China, 1990–1993

Commuting physical activity	Level of commuting physical activity (MET*-hours/week)								p_{trend}
	Low		Medium			High			
	Cases/ controls (nos.)	Odds ratio†	Cases/ controls (nos.)	Odds ratio†	95% confidence interval	Cases/ controls (nos.)	Odds ratio†	95% confidence interval	
Men									
Age period (years)‡									
20–29	175/275	1.0	173/277	1.01	0.71, 1.42	109/283	0.54	0.27, 0.93	0.01
30–44	181/273	1.0	169/274	0.89	0.56, 1.64	103/280	0.51	0.21, 0.90	0.006
45–54	171/270	1.0	164/274	0.94	0.47, 1.24	119/279	0.60	0.45, 0.94	0.03
≥55	141/250	1.0	138/254	0.99	0.77, 1.56	126/258	0.81	0.67, 1.43	0.12
Total duration (years)§									
25 (between ages 20 and 44)	119/141	1.0	87/109	0.81	0.42, 1.88	59/145	0.45	0.18, 0.88	0.001
25 (between ages 30 and 54)	93/123	1.0	68/96	0.88	0.39, 1.96	56/163	0.41	0.12, 0.81	<0.001
35 (between ages 20 and 54)	68/70	1.0	54/68	0.76	0.28, 1.91	32/91	0.34	0.09, 0.76	<0.001
Women									
Age period (years)‡									
20–29	162/214	1.0	170/211	0.91	0.62, 1.33	91/219	0.56	0.19, 0.92	0.03
30–44	171/226	1.0	162/226	0.87	0.56, 1.21	98/230	0.52	0.22, 0.94	0.01
45–54	151/207	1.0	146/208	0.84	0.43, 1.32	89/209	0.54	0.16, 0.87	0.04
≥55	127/154	1.0	121/149	0.98	0.68, 1.41	107/154	0.78	0.53, 1.32	0.19
Total duration (years)§									
25 (between ages 20 and 44)	91/121	1.0	76/110	0.88	0.35, 2.21	61/183	0.39	0.16, 0.83	<0.001
25 (between ages 30 and 54)	83/104	1.0	54/80	0.91	0.41, 1.88	69/163	0.46	0.31, 0.89	0.003
35 (between ages 20 and 54)	43/76	1.0	31/66	0.82	0.24, 2.48	26/123	0.31	0.07, 0.72	<0.001

* MET, metabolic equivalent.

† Adjusted for age, education, family income, marital status, total energy intake, intake of red meat, carotene, fiber, occupational physical activity, and leisure physical activity for both men and women and additional adjustment for number of pregnancies and menopausal status for women.

‡ Age period during which commuting physical activity was performed.

§ Total duration at which commuting physical activity was continuously performed at the designated level: low (low in all age periods); medium (mixed levels at different age periods); and high (high in all age periods).

Furthermore, there was significant interaction between commuting physical activity and body mass index levels, with the highest risks observed among those with low physical activity and high body mass index.

To date, most studies of colon cancer risk in relation to physical activity have been conducted in Western countries, and these studies mainly focused on occupational and leisure physical activities (1–6). Few investigations have been conducted in Asian populations, and none has examined the effect of commuting physical activity (14, 15). Findings from studies conducted in Asia are generally similar to those conducted in Western populations. In China, before the early 1990s, cycling and a combination of walking and riding buses were the most common means of transportation, accounting for a substantial proportion of physical activities in the population. Occupational physical activity was also a major source of physical activity in some occupations, while leisure physical activity was not commonly performed. Compared with occupational and leisure physical activities, which are more variable and comprised a wide variety of activities, commuting physical activity is more likely to be reported accurately because it is regularly performed as a daily activity and derived from fewer types of activities. In our study, the performance of commuting physical activity by each individual was relatively consistent over a long period of time, reflected by the large number of subjects who had the same levels of commuting physical activity for more than two decades, even as long as 35 years for some of them.

TABLE 4. Gender-specific risk of colon cancer by time spent on cycling and walking to work each day, Shanghai, China, 1990–1993

Commuting physical activity	Men			Women		
	Cases/ controls (nos.)	Odds ratio*	95% confidence interval	Cases/ controls (nos.)	Odds ratio*	95% confidence interval
Cycling (minutes/ day)†	462/851			466/701		
<30	92/121	1.0		117/147	10	
30–60	165/276	0.81	0.78, 1.21	161/192	0.76	0.82, 1.71
>60–120	148/321	0.52	0.42, 0.89	137/288	0.54	0.34, 0.91
>120	50/116	0.41	0.21, 0.83	32/71	0.44	0.12, 0.89
p_{trend}		<0.001			<0.001	
Walking (minutes/ day)†	297/454			326/517		
<15	117/155	1.0		98/127	1.0	
15–30	116/179	0.96	0.61, 0.17	138/194	0.87	0.62, 1.39
>30	64/120	0.71	0.38, 1.06	90/196	0.57	0.31, 0.93
p_{trend}		0.08			0.007	

* Adjusted for age, education, family income, marital status, total energy intake, intake of red meat, carotene, fiber, occupational physical activity, and leisure physical activity for men and women and additional adjustment for number of pregnancies and menopausal status for women.

† Cycling and walking were adjusted for each other in the analyses.

The level of commuting physical activity in our study population was relatively high. The cutpoint for the lowest level of commuting physical activity was 48.3 MET-hours/week, equivalent to about 7 hours of general jogging or playing tennis per week. It is noteworthy that the level of activities in the lowest tertile of subjects in our study was higher than the cutpoint for highest activity in a previous study conducted in Norway (16), in which colon cancer risk was reduced 38 percent with the equivalent of walking and cycling for at least 4 hours/week relative to a sedentary group among females. In our study, despite the relatively high baseline activity, we found further reduction in colon cancer risk with increasing levels of commuting physical activity. Results from these studies, along with previous studies of leisure and occupational physical activities which show a dose-response relation to colon cancer risk (1–5, 16), suggest that moderate increases in physical activity levels may confer further protection against colon cancer, regardless of the baseline activity levels.

While the mechanisms by which physical activity may affect colon cancer risk are not clear, several hypotheses have been proposed (5), including a shortening of bowel transit time by stimulation of colonic muscle motility that thereby reduces the duration of contact between fecal carcinogens and colonic mucosa; reduction of body fat and insulin resistance; enhancing the function of the immune defense by affecting T cells, B cells, natural killer cells, and interleukin-1 levels; and altering prostaglandin synthesis, bile acid metabolism, and the levels of serum cholesterol and gastrointestinal-pancreatic hormones, which may influence the growth and proliferation of colonic cells (5). The empirical evidence for these mechanisms is limited. Based on what is known about physical activity and colon cancer, it is likely that no one mechanism is fully responsible but that a set of complex mechanisms with physical activity is involved in reduction of colon cancer risk.

Limited studies have assessed the joint effects of physical activity and body mass index on colon cancer risk. Consistent with findings from a recent study (6), our results showed that low physical activity and high body mass index are independent risk factors and that their effects on colon cancer risk can be modified by the presence of each other. As with body mass index, physical activity is also a strong determinant of insulin resistance and hyperinsulinemia (17–19). Although highly correlated with body mass index, physical activity appears to modify insulin sensitivity independently of the effect of body mass index. Therefore, it is conceivable that the presence of both risk factors may enhance the effect on insulin sensitivity, which may explain, in part, the significant interaction that we observed between body mass index and physical activity on colon cancer risk.

Several strengths of this population-based study are noteworthy. The high participation rate in both cases and controls minimizes selection bias. The large study size permits detailed evaluation of risk by anatomic subsite of tumor origin, effect modifications between body mass index and physical activity, and the effect of commuting physical activity at various age periods. The consistency and regularity of commuting physical activity in daily life may enhance recall of these activities, while the wide range of activity levels may enhance the assessment of the dose-response relation with colon cancer risks. Selective recall was not likely, since physical inactivity was not well known to be a risk factor for colon cancer in our study population. However, because of the retrospective nature of this study, such a possibility cannot be entirely dismissed.

TABLE 5. Gender-specific risk of colon cancer in relation to level of commuting physical activity and usual body mass index, Shanghai, China, 1990–1993

Commuting physical activity	Quintile of usual body mass index*															p_{trend}†
	Quintile 1			Quintile 2			Quintile 3			Quintile 4			Quintile 5			
	Cases/ controls (nos.)	Odds ratio‡	95% confidence interval	Cases/ controls (nos.)	Odds ratio‡	95% confidence interval	Cases/ controls (nos.)	Odds ratio‡	95% confidence interval	Cases/ controls (nos.)	Odds ratio‡	95% confidence interval	Cases/ controls (nos.)	Odds ratio‡	95% confidence interval	
Men																
High	17/40	1.0		23/50	1.12	0.32,1.89	15/55	1.12	0.46, 1.92	23/64	1.12	0.56, 1.92	25/79	1.22	0.57, 2.13	0.42
Medium	25/60	1.09	0.56, 2.02	30/57	1.35	0.65, 1.98	24/64	1.24	0.41, 2.09	29/46	1.78	0.91, 2.15	32/52	2.61	1.19, 3.75	0.04
Low	38/71	1.07	0.44, 1.85	32/61	1.46	0.78, 2.93	29/50	1.62	0.82, 3.29	57/60	3.41	1.12, 4.92	62/38	6.43	1.82, 8.54	<0.001
p_{trend}§		0.64			0.54			0.22			0.02			<0.001		
$p_{interaction}$¶															0.002	
Women																
High	27/50	1.0		20/45	1.07	0.53, 1.85	19/43	0.98	0.42, 1.72	20/45	1.12	0.31, 1.69	24/53	1.17	0.7, 1.89	0.48
Medium	26/45	1.14	0.51, 2.64	21/43	1.18	0.42, 2.05	20/43	1.06	0.49, 1.84	19/41	1.31	0.72, 2.16	35/56	2.47	1.44, 4.13	0.02
Low	33/44	1.42	0.47, 2.35	50/53	1.71	0.98, 2.64	41/51	1.98	1.04, 3.10	53/53	3.56	1.16, 6.46	57/30	7.42	2.84, 10.01	<0.001
p_{trend}§		0.43			0.32			0.12			0.004			<0.001		
$p_{interaction}$¶															<0.001	

* Quintiles of body mass index based on gender-specific distributions among control subjects. The following cutpoints were used: quintile 1: <19.2, quintile 2: 19.2–20.3, quintile 3: 20.4–21.3, quintile 4: 21.4–22.8, and quintile 5: >22.8 for men; and quintile 1: <19.0, quintile 2: 19.0–20.5, quintile 3: 20.6–21.9, quintile 4: 22.0–23.6, and quintile 5: >23.6 for women.

† p_{trend} across body mass index categories within each group of commuting physical activity.

‡ Adjusted for age, education, family income, marital status, total energy intake, intake of red meat, carotene, and fiber for both men and women and additional adjustment for number of pregnancies and menopausal status for women.

§ p_{trend} across commuting physical activity categories within each group of body mass index.

¶ $p_{interaction}$ between body mass index and commuting physical activity.

In conclusion, our results show a reduction in colon cancer risk with increasing levels of commuting physical activity, as indicated by increasing hours spent on cycling or walking for the daily commute and the number of years maintained at a high level of commuting physical activity. The effects of physical activity on colon cancer are independent of those of body mass index, but their effects can be modified by each other. These findings underscore the importance of regular physical activity over the lifetime in the prevention of colon cancer, particularly among overweight individuals.

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